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AFATL-TR-74-115

DESIGN AND DEVELOPMENT OF FMU-120/B BOMB FUZE

FAIRCHILD CAMERA AND INSTRUMENT CORPORATION

TECHNICAL REPORT AFATL-TR-74-115

JULY 1974

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Design And Development Of FMU-120/B Bomb Fuze

David Goldstein

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FOREWORD

This technical report describes the design and development program for a modified FMU-114/B Bomb Fuze (later designated as the FMU-120/B). The major portion of the program effort described herein was conducted essentially during the period 10 November 1972 through 1 February 1974 by the Fairchild Camera and Instrument Corporation, 300 Robbins Lane, Syosset, N.Y. This effort was conducted for the Air Force Armament Laboratory, Armament Development Test Center, Eglin Air Force Base, Florida, under Contract No. F08635-73-C-0049. The work performed under this contract was monitored by Captain Stanley G. Hull (DLJF).

This technical report has been reviewed and is approved for publication.

FOR THE COMMANDER

FENDRICK J. SMITH, JR., Colonel, USAF
Chief, Munitions Division

ABSTRACT

This report relates the results of the applied research, design, development and testing of the FMU-120/B Bomb Fuze. The program was successful with regard to meeting the technical goals of (1) functional compatibility with nose well installation, (2) electrically powered from the accessible and visible front face of the fuze, (3) compatibility with the laser guided bomb (LGB) and HOBO EO Weapon Systems, (4) providing operation from a 200-VDC to 300-VDC supply, and (5) including ground selectable 5.5-and 12.0-second arming times. Laboratory and field tests have demonstrated that the developed fuze meets the environmental and functional boundaries as delineated in the subject scope of work. The final fuze design was designated as the FMU-120/B Guided Bomb Proximity Fuze.

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DESIGN AND DEVELOPMENT

1.1 INTRODUCTION

The modified FMU-114/B Bomb Fuze (hereinafter referred to as FMU-120/B) was developed by Fairchild Space and Defense Systems as an adjunct to the then ongoing development program for the FMU-114/B. The FMU-120/B includes features and a configuration to achieve physical and functional compatibility with both the HOBO EO and LGB Weapon Systems.

1.2 PROGRAM BACKGROUND

The development of the FMU-114/B had been initiated under Contract No. F08635-72-C-0169 to Fairchild Camera and Instrument Corporation before the start of this program. The FMU-114/B (Figure 1) is a simplified, redesigned version of the U.S. Navy MK344 Bomb Fuze (Figure 2) and is designed to operate as a nose or tail fuze powered by an air-driven FZU-32/B Bomb Fuze Initiator. The FMU-114/B can be used in conjunction with the MK43 Target Detecting Device (TDD) to achieve an above ground detonation of low drag, general purpose bombs. The fuze employs much of the circuitry and components of the MK344.

This program for the development of the FMU-120/B Bomb Fuze was initiated because of the requirement for rapid development of a proximity fuze system for use with the (1) HOBO electro-optical (EO) guided bomb, which is equipped with the KMU-353 Bomb Kit and (2) the laser guided bomb (LGB), which is equipped with the KMU-351 Bomb Guidance Kit. By using the then recently developed FMU-114/B as a baseline, much time could be saved in development of a suitable fuze for accomplishing the safing and arming functions of the proximity fuze system. The Infrared (IR) proximity sensor, developed under separate contract would be used to provide both the proximity firing signal and electrical power to the fuze.

1.3 SCOPE AND OBJECTIVES

The scope of this program encompassed the design, development, fabrication, assembly, test and evaluation of the FMU-120/B Bomb Fuze for the HOBO EO and LGB Weapon Systems. Included within the effort was data covering various aspects of the design, safety, operation and piece parts.

The major objectives of the effort centered about alteration of the FMU-114/B Fuze while retaining desirable characteristics, such as

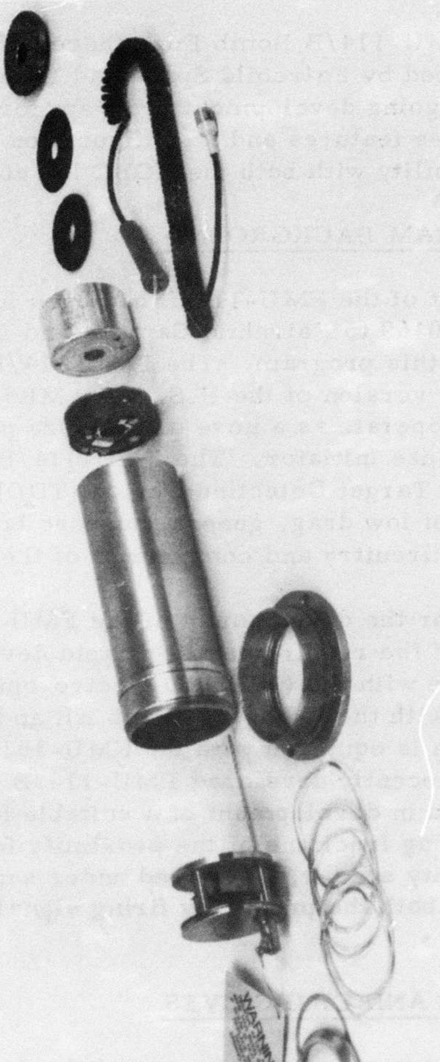

Figure 1. FMU-114/B Bomb Fuze

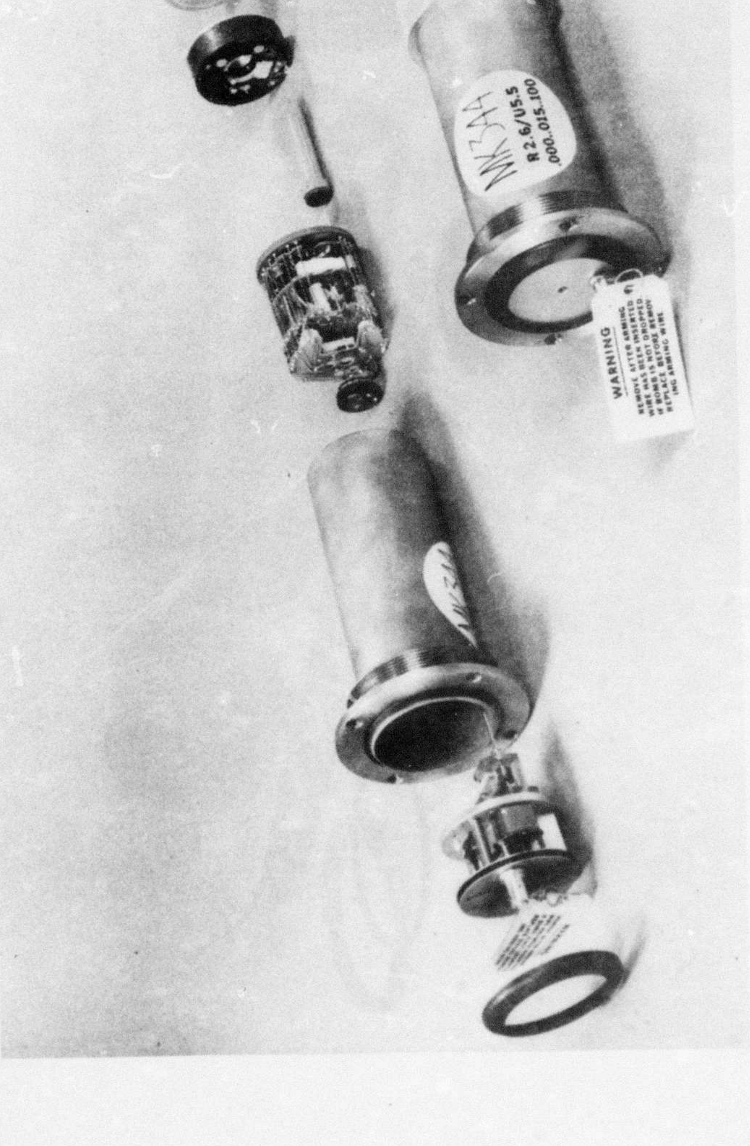

Figure 2. MK344 Bomb Fuze

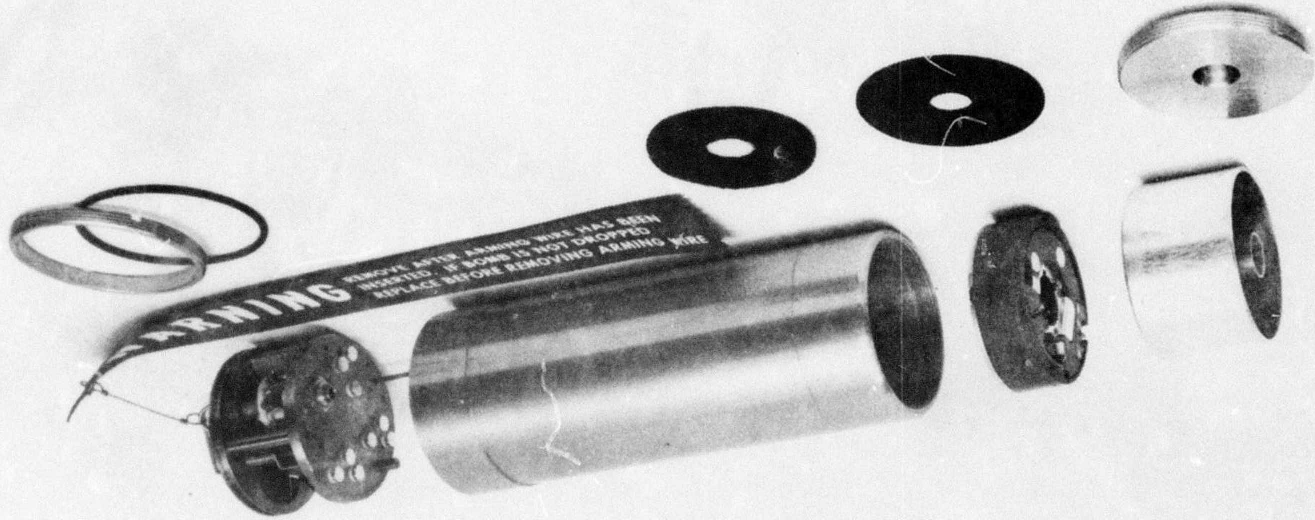

Figure 3. FMU-120/B Bomb Fuze

reliability and safety. Areas of modification were as follows:

(1) Compatibility - The modified fuze was to be functionally and physically compatible with installation within the bomb nose well with the EOGB or LGB guidance kit attached.

(2) Electrical Power - A connector to accept both electrical power and fire signals, was required at the forward face of the fuze. Fuze power was to be provided by a thermal battery, which was an integral part of the proximity sensor.

(3) Selectable Arm Times - Ground selectable arming times of 5.5 seconds and 12.0 seconds were to be incorporated into the fuze.

1.4 DESIGN DESCRIPTION

The FMU-120/B Fuze (Figure 3) consists of four major subassemblies, i.e., a mechanical safety device (Figure 4), an electronics section (Figure 5), a rotor assembly (Figure 6), and a booster assembly (Figure 7).

The FMU-120/B Fuze may be installed in the nose fuze well of a MK84 Bomb with either the KMU-353 Electro-Optical Guidance Kit or the KMU-351 Laser Guidance Kit. It has ground selectable arming delay times of 5.5 seconds and 12 seconds, selected by a screwdriver-operated switch on the forward face of the fuze. This fuze receives electrical power and an electrical fire (detonate) signal from a proximity sensor. It also contains a backup impact function mode of operation. The fuze is a derivative of both the FMU-114/B and MK344 Fuzes. The explosive train (detonator, lead cup and booster assembly) is identical to the FMU-114/B and MK344 Fuzes.

Schematic diagrams of both the FMU-114/B and FMU-120/B Fuzes are shown in Figures 8 and 9, respectively. A detailed component by component description of Figure 9 is given in the following paragraphs. Figure 9 consists basically of four functional blocks: the voltage regulator circuit, the primary arming ciruit, the secondary arming circuit and the proximity and impact firing circuits. These blocks are virtually independent and are discussed separately.

1.4.1 Voltage Regulator Circuit

All reference numbers of components discussed in the following paragraphs refer to board No. 2, Regulator Board Assembly, unless otherwise noted.

The input voltage to the fuze (250 ± 50 volts) is applied at pin C of connector J1, and, after 1 second, it appears at TP16. Charging current

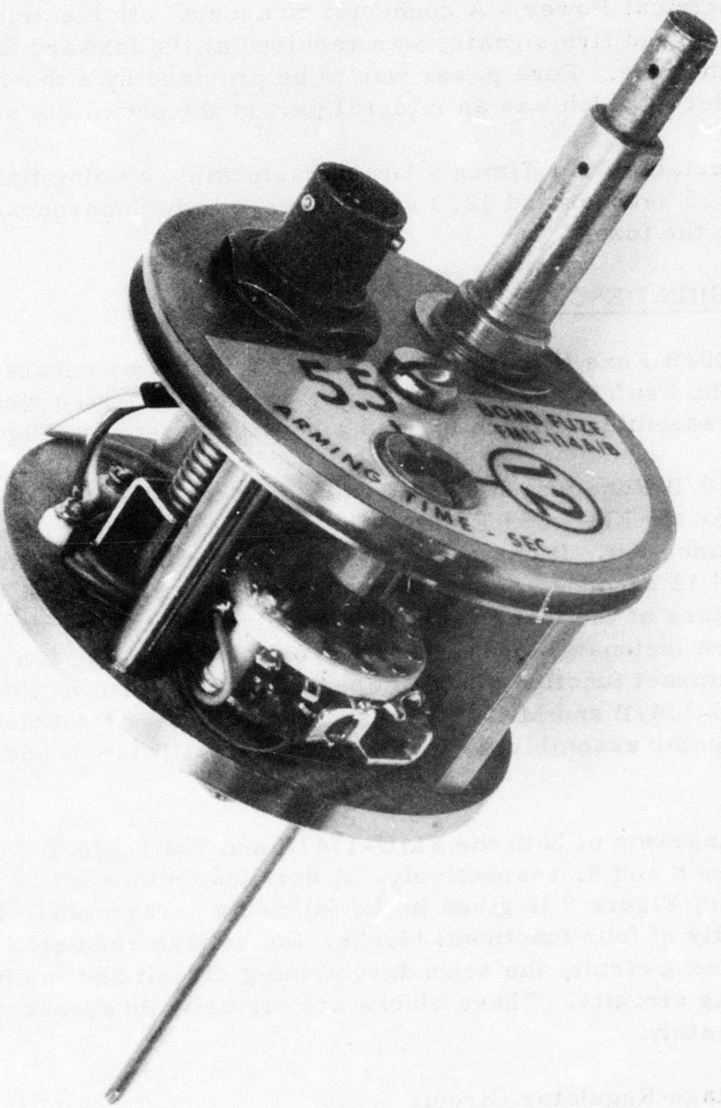

Figure 4. Modified MK31 Safety Device

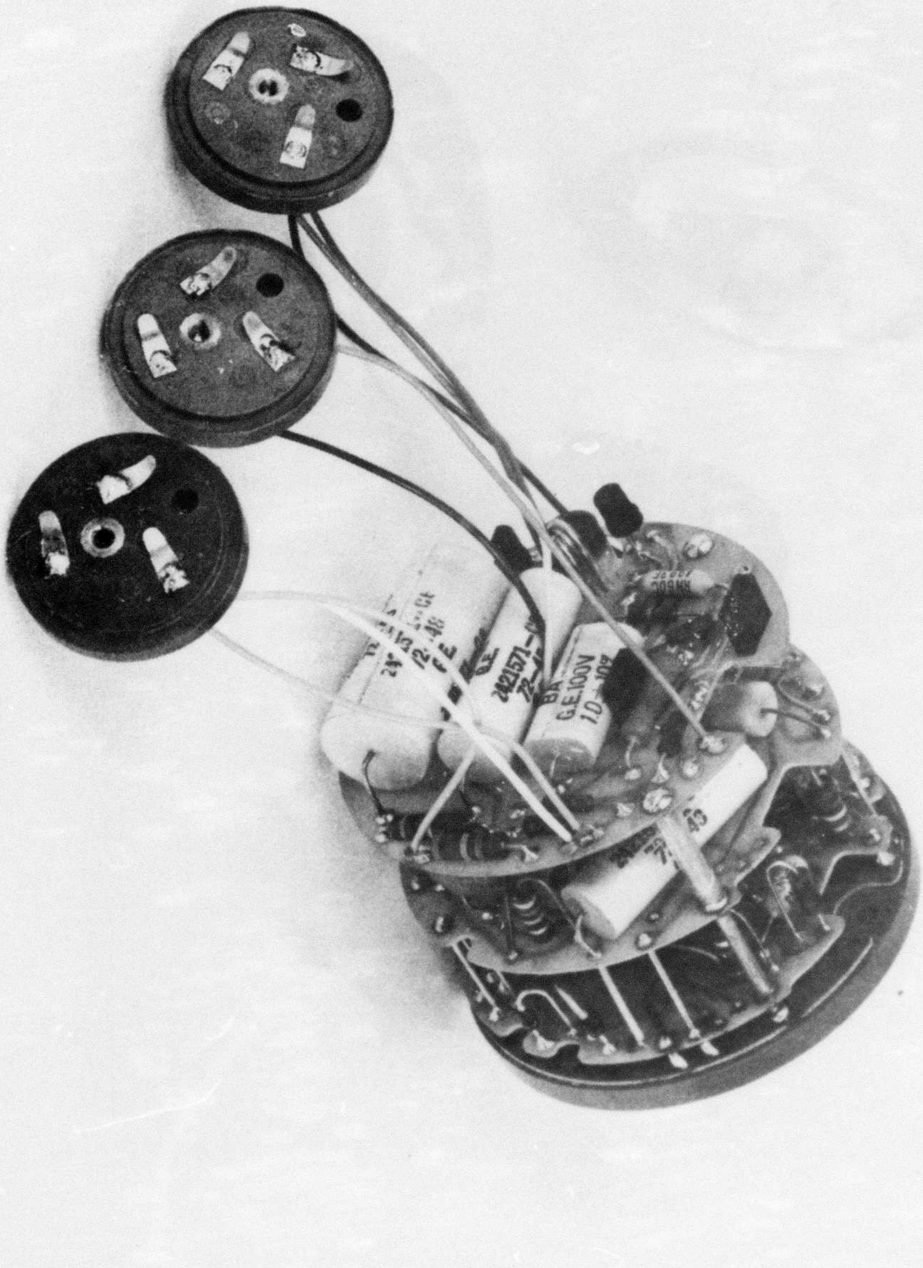

Figure 5. Electronics Section

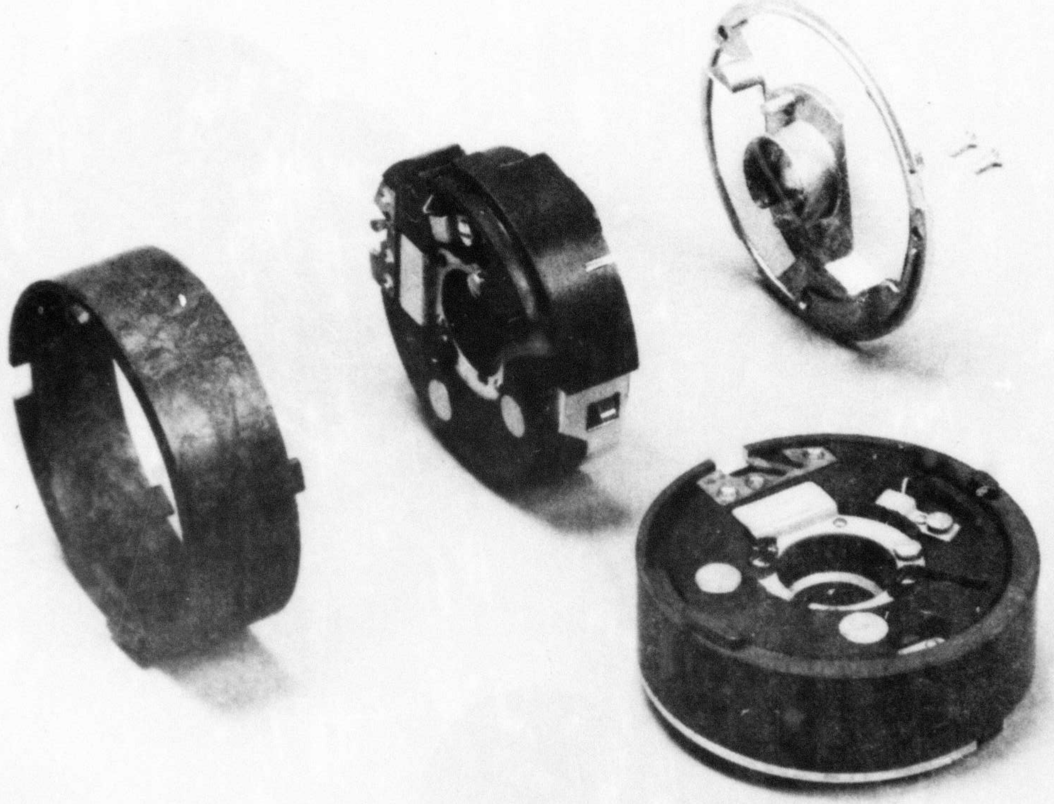

Figure 6. Rotor Assembly

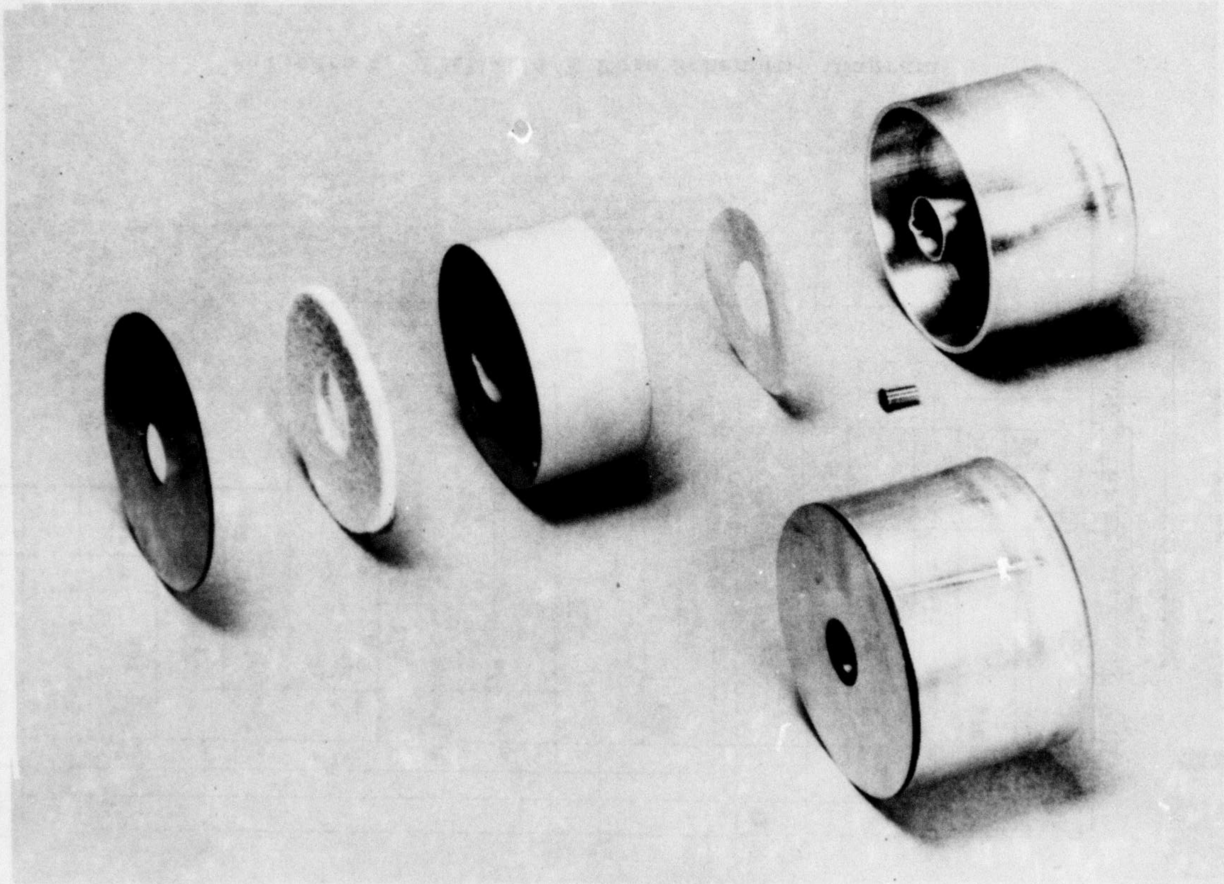

Figure 7. Booster Assembly

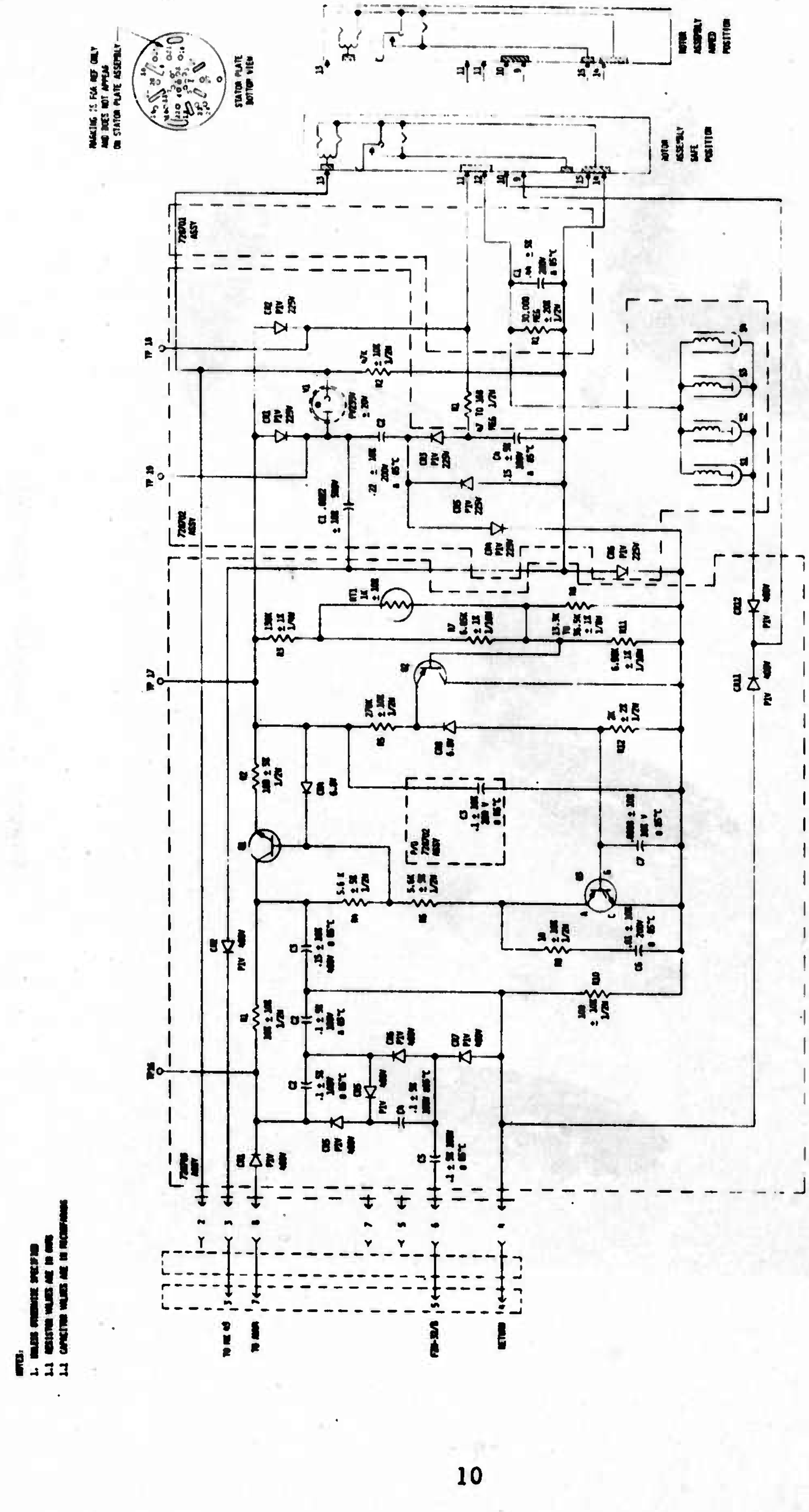

Figure 8. FMU-114/B Fuze Schematic Diagram

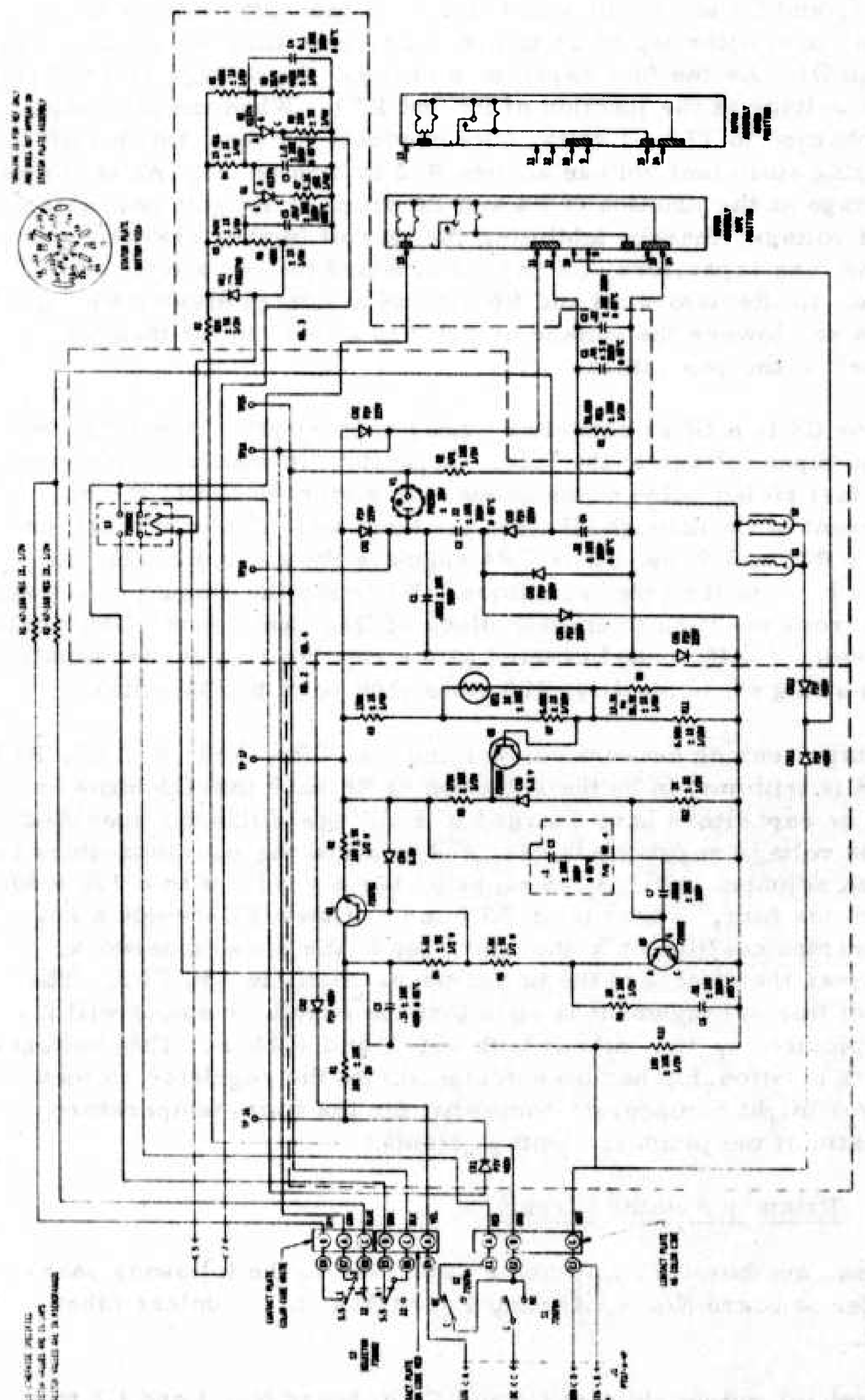

Figure 9. FMU-120/B Fuze Schematic Diagram

flows through R1, R2 and Q1 into the fuze capacitors, C2 and C3 of board No. 4, and C1 and C2 of board No. 3. Diode CR4 clamps the voltage across the emitter leg of Q1 to 6.8 volts, thus limiting the peak current through Q1. As the fuze capacitors charge, the voltage at TP17 rises as does the voltage at the junction of R3 and RT1. When the fuze capacitors have charged to 177 ± 1 volts, CR8 conducts current, turning off Q2 and developing sufficient voltage across R12 to turn on Q3. As Q3 turns on, the voltage at the junction of R4 and R6 drops to roughly one-quarter of the input voltage, thereby inhibiting the flow of further charging current into the fuze capacitors, C2 and C3 of board No. 4, and C1 and C2 of board No. 3. Resistors R4 and R6 act as a voltage divider which, as Q3 turns on, lowers the voltage at TP17 to a level lower than the voltage level on the capacitors.

Capacitor C3 is a filter capacitor whose sole purpose is to filter out noise on the input voltage to the fuze. Capacitor C6 makes Q3 less sensitive to a fast rising pulse on its anode. Resistor R9 limits the discharge current of C6 through Q3 when Q3 turns on. Transistor Q1 emitter resistor R2, and Zener diode CR4 regulate the amount of charging current flowing into the fuze capacitors. By fixing the amount of voltage available across the base to emitter diode of Q1, Zener diode CR4 minimizes the voltage differential created at the regulator output terminals by an input swing of, nominally, 100 volts (300 volts to 200 volts).

The voltage sensing network comprising R5, CR8, R12, R3, R7, RT1, R11 and R8 is trimmed in by the selection of R8 such that Q3 turns on when the fuze capacitors have charged to a voltage within the specified range. The voltage regulator is designed to allow the fuze capacitors to charge to an adjusted value in the range of 177 ± 1 volts with a 250 ± 50-volt input to the fuze. Thermistor RT1 and resistor R7 provide a negative temperature coefficient to the upper leg of the sensing network, which balances the effects of the temperature coefficient of CR8. The net result of this arrangement is such that the regulator output will increase, typically, by 4.0 volts at both -65°F and +160°F. This voltage-temperature relationship has been designed into the regulator so that the regulator might compensate somewhat for the time-temperature characteristic of the primary arming circuit.

1.4.2 Primary Arming Circuit

All reference numbers of components discussed in the following paragraphs refer to board No. 4, Arming Board Assembly, unless otherwise noted.

The regulator output charges C1 and C2 of board No. 3 and C2 to a fixed voltage (177 ± 1 volts). Capacitors C1 and C2 of board No. 3 immediately begin to discharge into C4 through either R1 or R2 (47-168

megohms), shown at the top of Figure 9, depending upon whether the 5.5-second or the 12-second mode has been chosen. In the case where nominal values of C1, C2, R1, R2, C4, Vo (the regulator output voltage) and V1 are involved, C4 charges to 58 volts in either 4.5 seconds or 11 seconds (depending upon whether the 5.5-second or the 12-second mode has been chosen). At this time, the sum of the voltages on C2 and C4 is sufficient to cause V1 to conduct. Capacitor C2 then discharges through V1 and a set of contacts on the explosive switch S3 (if the 12-second mode has been chosen), into the explosive bellows drivers, located in the rotor, to arm the unit. The firing time of 4.5 seconds is denoted as TA2, and the firing time of 11 seconds is denoted as TA2'.

Components C1 and C2 of board No. 3, R1 and R2 (top of Figure 9), C4, V1 and Vo determine the time constant of the circuit. Resistors R1 and R2 are used as trimmers to bring the timer into the desired time range, either 4.5 seconds or 11 seconds. The components CR1, CR2, CR3, CR4 and CR6 provide decoupling during either the charge cycle or the timing cycle. Diode CR5 bypasses C4 during the discharge of C2.

Resistor R1 of board No. 3 is a bleeder resistor intended to discharge C1 and C2 of board No. 3 in approximately a twenty-four hour period to a point where the energy remaining would be insufficient to fire the detonator or complete these capacitors' timing function. Resistor R2 sterilizes the output of the timer in the event that the output pulse does not reach the explosive bellows drivers.

1.4.3 Secondary Arming Circuit (TA1)

All reference numbers of components discussed in the following paragraphs refer to board No. 3, Energy Storage Board Assembly, unless otherwise noted.

The secondary arming circuit receives power from the input voltage to the fuze (250 ± 50 volts) and this voltage passes through the Zener diode regulator network, consisting of R2 and VR1. After regulation, a somewhat lower voltage appears at the cathode of VR1. Capacitor C3 begins to charge through resistor R4 and the voltage at the anode of Q2 begins to rise. The voltage at the gate of Q2 is constant and is set by bias resistors R5 and R9. When the voltage at the anode of Q2 exceeds the gate voltage by about 0.5 volt, Q2 conducts. Capacitor C3 discharges through Q2 and into the bridge wire of explosive switch S3 of board No. 4. When the explosive switch fires, continuity is established between the primary arming circuit and the explosive bellows drivers located in the rotor (if the 12-second mode has been chosen).

The firing time of the circuit is determined by R4, C3, Q2, R5 and R9. Nominally, this time is 9 seconds, and it is denoted as TA1. Resistor

R9 is a select resistor used to adjust the firing time to 9 seconds. Resistor R8 sterilizes the output of the circuit in case of an open in the bridge wire of the explosive switch. The Zener diode regulator network consisting of R2 and VR1 is used to regulate the input voltage down to a level compatible with the programmable unijunction transistors Q1 and Q2. Components R3, R6, C5, Q1, R7 and C4 are used to sterilize the output of the circuit in the event of a loss of power to the fuze during the timing cycle. The voltage at the gate of Q1 is set by resistors R3 and R6 at a higher level than the gate of Q2 so that Q1 will never conduct in the normal operation. If power to the fuze is lost, the voltages at the gate of Q1, the anode of Q2 and the gate of Q2 drop to zero at different rates. First, the gate of Q1 drops to zero, then the gate of Q2 and last the anode of Q2. This means that the gate of Q1 drops below the voltage at the anode of Q2 before the gate of Q2 does. This also means that Q1 will conduct before Q2. Capacitor C3 will discharge through Q1 and resistor R7 and the circuit will be sterilized of any residual charge.

1.4.4 Proximity and Impact Firing Circuits

The proximity firing circuit is located in the proximity sensor that interfaces with the fuze. The output of this circuit passes through the fuze electronics assembly to fire the detonator located in the rotor. The impact firing circuit consists of components C1, C2 and R1 of board No. 3 and impact switches S1 and S2 of board No. 4. Upon impact, the remaining charge on capacitors C1 and C2 of board No. 3 is discharged through the impact switches and through the detonator located in the rotor. Diodes CR2, CR11 and CR12 of board No. 2 are used to decouple the proximity firing circuit from the impact firing circuit, since the proximity firing circuit provides a negative pulse and the impact firing circuit provides a positive firing pulse to the same detonator.

1.5 FUNCTIONAL OPERATION

The functional operation of the FMU-120/B Fuze (Figure 10) in both the proximity and backup impact modes is as follows:

Normal Proximity Function

(1) The arming wire (lanyard) is extracted from the mechanical safety device assembly upon bomb release from the aircraft.

(2) The safety device assembly begins a 4-second timing sequence controlled by a mechanical delay escapement mechanism.

NOTES:

1. ALL TIMES ARE REFERENCED FROM SAFETY DEVICE ASSEMBLY ACTUATION (LANYARD PULL).

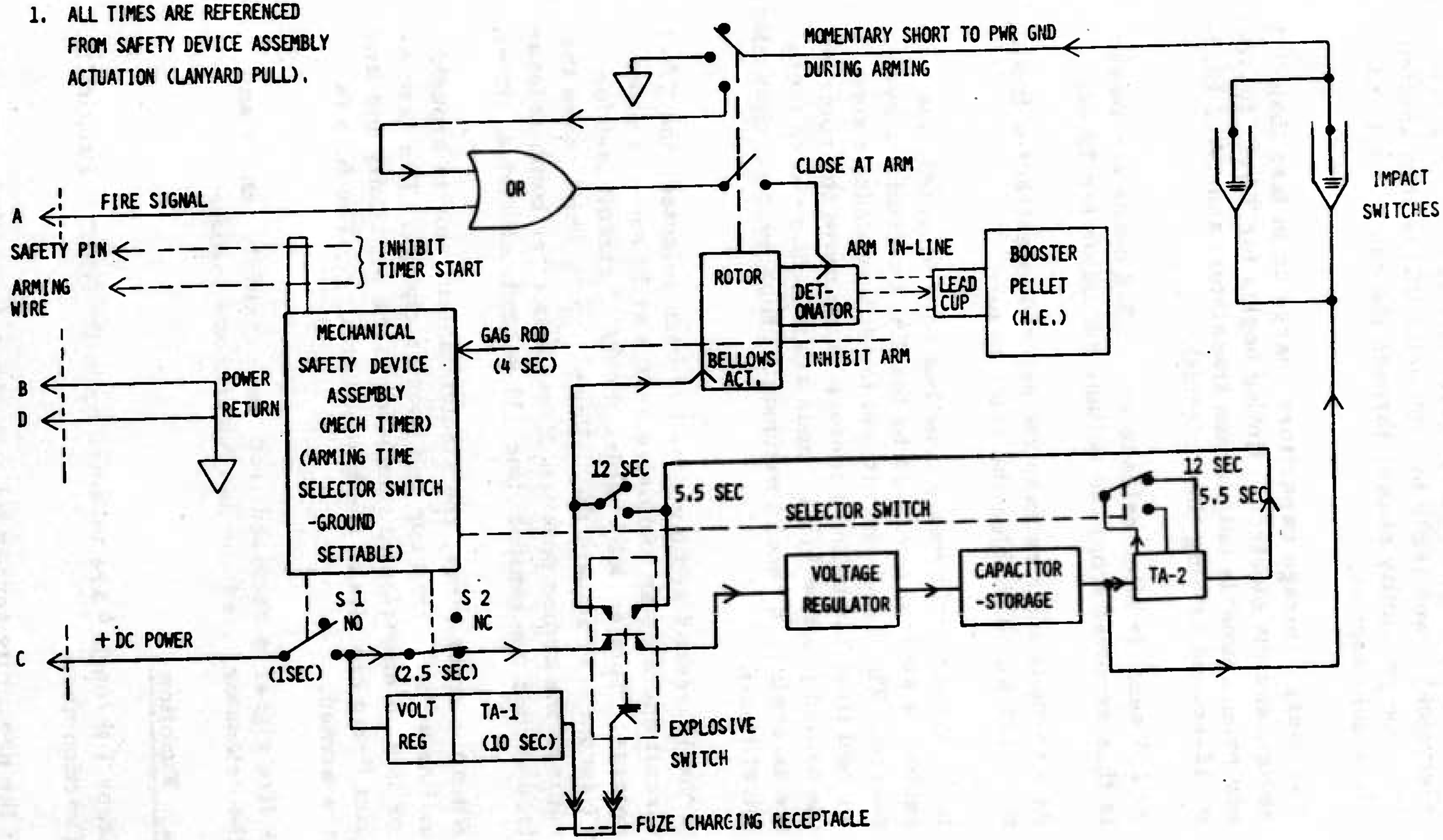

Figure 10. FMU-120/B Fuze Functional Block Diagram

(3) Normally open switch S-1 closes one second after release. Electrical power (+200 to +300 volts DC) is then applied from the proximity sensor through the connector to the electronic section.

(4) The energy storage capacitors charge up in less than 0.1 second and the electronic timing begins for TA-1 (10-second programmable unijunction transistor) and TA-2 (5.5- or 12-second arming time circuit).

(5) At 2.5 seconds after release switch S-2 opens and power is thus removed from the voltage regulator for TA-2.

(6) At 4 seconds after release the gag rod is extracted from the rotor which enables the rotor to turn.

(7) If the 5.5-second arming time has been selected, the explosive switch, operated by the TA-1 circuit, is bypassed. The TA-2 circuit (set for 4.5 seconds) times out and fires the bellows motors which move the rotor to the armed position 5.5 seconds after bomb release from the aircraft (1.0 second mechanical time +4.5 seconds electrical time).

(8) If the 12-second arming time has been selected, the TA-1 circuit operates an explosive switch at 10 seconds after release. This switch enables the TA-2 circuit (set for 11 seconds) to actuate the bellows motors which move the rotor to the armed position 12 seconds after bomb release (1.0 second mechanical time +11 seconds electrical time).

(9) When the rotor turns, the electrical detonator is brought in-line with the lead cup and booster charge. The detonator is also electrically connected to the proximity and impact firing circuits at the time of arming. The fuze is now armed.

(10) A fire signal is received from the proximity sensor and the detonator, lead cup and booster are initiated.

<u>Alternate Function</u>

(1) Steps 1 through 9 are followed as in the Normal Proximity Function above.

(2) If the proximity sensor fails to give a fire signal, or some damage or malfunction prevents the fire signal from reaching the detonator, backup impact detonation is provided.

(3) When the bomb impacts the ground, the deceleration shock will cause one or both of the impact switches (operating in parallel) to close.

(4) A single or dual impact switch closure will cause the capacitor's stored electrical energy to discharge to fire the detonator, lead cup and booster.

The fuze contains operational and safety features as described below:

(1) Electrical power cannot be applied to the fuze until the arming wire is extracted and 1 second of time has elapsed.

(2) If the bellows actuation is initiated before the gag rod is withdrawn from the rotor, the rotor will jam against the gag rod causing the fuze to dud in a safe position.

(3) If electrical power to the TA-1 circuit is interrupted during operation, the TA-1 timer resets. A momentary power interruption causes reset and restart of the cycle.

(4) Once the explosive switch is fired, power cannot be applied to TA-2 or to the storage circuit.

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SECTION II

PROGRAM PERFORMANCE HISTORY

2.1 PRESCRIBED TASKS

The program for development of the FMU-120/B Fuze was divided into a number of major subtasks. First, the fuze design was evolved, taking advantage of knowledge gained by component and subsystem testing. Following interim and preliminary design reviews and delivery of two non-functioning configuration models, approval of the design was to be obtained before further effort was expended. Upon government approval, 230 fuzes were to be built of which 20 were to be subjected to contractor testing. The remaining fuzes were to be shipped, in various configurations, to a number of government designated destinations. Fairchild was also responsible for engineering field support and data as delineated in the contract.

2.2 HISTORY OF PROGRAM

The program started on 10 November 1972. The initial contractor efforts were directed at reviewing the FMU-114/B Fuze design to determine the specific design changes required to meet the requirements, with emphasis on the physical and electrical interface requirements.

An interim program review was held at Fairchild on 30 November 1972, at which time Fairchild presented the proposed modified design. Agreement on a basic interface configuration was reached; however, it was decided that further review and design effort were required in certain areas, primarily the 12-second arming time circuit.

Fairchild conducted design evaluation testing on five prototype electronics assemblies during the period between 12 and 14 December 1972. The results of this evaluation confirmed the feasibility of the proposed design.

Leak testing of prototype hardware was successfully completed on 14 December 1972.

The preliminary design review was held at Fairchild on 14 December 1972. As a result of this review, a number of changes were made, primarily with regard to electrical interface requirements, and design requirements for fuze function. The directed changes were as follows:

(1) The uncertainty in turn-on time of the power supplied to the fuze led to a decision to modify the fuze design so as to pro-

vide a power switch within the mechanical timer of the fuze. This switch applies power to the fuze electronics 1.0 second after removal of the fuze lanyard. Uncertainty with regard to power supply power requirements led to a decision to include a 10K resistor within the fuze as a current-limiting device on the fuze input power line.

(2) As a result of Air Force review of the design from a safety viewpoint, a dual electrical timer was needed for the 12-second mission. Inclusion of this parallel timer was directed.

As a result of these changes the program schedule was extended for four weeks.

Two configuration models were delivered to the Air Force on 22 December 1972 for EOGB and LGB weapon compatibility testing.

During the period 14 December 1972 through 16 January 1973, Fairchild conducted evaluation of five prototype timer circuits for use as a parallel timer in the 12-second mode. In addition, the other required design changes were implemented.

A design review meeting was held at Eglin Air Force Base on 16 January 1973 at which Fairchild described the proposed design. As a result of this review, the Air Force gave approval to proceed with the fabrication of the 230 deliverable fuzes.

A number of critical hardware delivery problems were uncovered when the purchase orders for the hardware were placed. The most critical ones were printed circuit boards, selector switches, 15-megohm resistor, programmable unijunction transistor, and S_1/S_2 power control switches.

As of 25 February 1973, with the exception of the printed circuit boards, small quantities of all the above critical hardware deliveries scheduled prior to 25 February 1973 had been met.

The first delivery of printed circuit boards occurred during the second week in March. Inspection of the energy storage board (P/N 728791) revealed a minor problem due to a design error. It was determined that the board could be used by rerouting one of the component leads, and this change was incorporated.

Six fuzes in a 50900-20[1] configuration were shipped to Eglin Air Force Base on 23 March for electrical compatibility tests with IR proximity sensors. Four of these fuzes were functioned in a proximity mode, and two in an impact mode. One of the fuzes armed successfully but failed to function in the impact mode. It was determined that the proximity firing circuit was operative, and that the fuze probably would have functioned in the proximity mode. The other fuzes performed properly.

Two fuzes in a 50900-30 configuration were shipped to the Columbus Division of North American Rockwell on 26 March. These fuzes were scheduled for use in EMI tests.

Seventeen fuzes were loaded at Colt Industries (Atglen, Pa.) on 29 March and shipped to Eglin Air Force Base on 31 March.

The delivery of 250 Oak selector switches (P/N 50779) scheduled for 23 March 1973 was slipped to 13 April. In order to minimize delays in scheduled fuze deliveries, an order for 60 additional Centralab switches was placed. The Centralab switches would be used if Oak switches were not received in a timely manner. This provided enough switches for a total build of 170 fuzes (less shrinkage) pending receipt of switches from Oak.

Sixteen fuzes were subjected to environmental tests at Fairchild during the period 1 April through 19 April. These fuzes were functioned at Fairchild on 19 April and 20 April.

Additional deliveries made during April 1973 included:

12 fuzes,	-20 configuration,	Fairchild to Eglin on 4/4
16 fuzes,	-30 configuration,	for Fairchild tests, 4/1-4/5
24 fuzes,	-10 configuration,	Colt to Eglin on 4/6
17 fuzes,	-20 configuration,	Colt to Eglin on 4/6
6 fuzes,	-20 configuration,	Fairchild to Eglin on 4/6
24 fuzes,	-10 configuration,	Colt to Eglin on 4/18
24 fuzes,	-20 configuration,	Colt to Eglin on 4/18

[1] Configuration Description
50900-10: completely loaded unit.
50900-20: MK100 detonator only; inert lead and booster.
50900-30: An explosive driver in place of the MK100 detonator; inert lead and booster.

Delivery of the remaining 82 fuzes, required to satisfy the full 230-fuze contract quantity, was delayed until February 1974 because of funding difficulties and termination of the Air Force test program.

SECTION III

TESTING

The FMU-120/B Fuze and fuze components and subassemblies were subjected to contractor testing during various stages of the development program.

3.1 DESIGN TESTING - COMPONENT EVALUATION

The test program was initiated with a series of investigatory studies into the behavior of candidate circuits for the voltage regulator. The voltage regulator circuit is the dominant factor in determining the fuze arming time and temperature effects are most critical to this circuit's operation. Consequently, a concerted effort was made to obtain temperature characteristics in which the regulator voltage would increase no more than 2 percent above the nominal 177 volts at both temperature extremes when compared to ambient operation. Various circuits were breadboarded and tested on 28 November, 9 December, and 12 December 1972. The results of these tests indicated that the voltage regulator circuit to be used in the design operated successfully within the desired temperature characteristics.

Informal testing of the seal area of the fuze at the safety device interface was conducted on mock up systems. The results indicated that the fuze was capable of being waterproof sealed.

3.2 COMPONENT TESTING

The FMU-120/B Fuze contains a number of components that require unique and fully defined inspection/test in order to preclude use of substandard material. Included among these components are the programmable unijunction transistors, the silicon controlled switch, the 15-megohm,1 percent resistor, the power control microswitches, the Zener diode IN5274B, the thermistor 2DC 102 and the selector switch. As lots of each of these critical components were received they were tested in accordance with prescribed test procedures.

3.3 TIMING TESTS

Each fuze built was tested for timing before and after encapsulation. A series of special tests were conducted on a random sample of six fuzes. These tests were conducted from 10 April through 14 April 1973. The results of the tests are tabulated in Table 1.

TABLE 1. TEMPERATURE/TIME TESTING RESULTS OF RANDOM SAMPLE OF SIX FMU-120/B FUZES

S/N	TA1	TA2/TA2'	TEMP (°C)	DATE	TIME
		TA2			
92	9.24	4.79	-55	4/10	8:30 AM
93	9.07	4.87			
104	9.41	4.92			
113	9.35	4.96			
116	9.14	6.11			
117	9.01	4.95	-55	4/10	8:30 AM
		TA2'			
92	9.25	11.38	-55	4/10	4:00 PM
93	9.06	11.45			
104	9.40	11.98			
113	9.36	11.91			
116	9.13	14.24			
117	9.01	11.99	-55	4/10	4:00 PM
		TA2			
92	9.23	4.68	-40	4/11	8:30 AM
93	9.06	4.57			
104	9.37	4.69			
113	9.34	4.77			
116	9.12	5.71			
117	8.98	4.73	-40	4/11	8:30 AM
		TA2'			
92	9.23	10.91	-40	4/12	8:30 AM
93	9.06	11.01			
104	9.37	11.30			
113	9.34	11.37			
116	9.11	13.34			
117	8.99	11.45	-40	4/12	8:30 AM
		TA2			
92	9.15	4.65	0	4/12	4:00 PM
93	9.00	4.46			
104	9.27	4.61			
113	9.25	4.71			
116	9.05	4.82			
117	8.93	4.61	0	4/12	4:00 PM

TABLE 1. TEMPERATURE/TIME TESTING RESULTS OF RANDOM SAMPLE OF SIX FMU-120/B FUZES (Concluded)

S/N	TA1	TA2/TA2'	TEMP (°C)	DATE	TIME
		TA2'			
92	9.15	10.81	0	4/13	8:30 AM
93	9.00	10.68			
104	9.27	11.10			
113	9.25	11.08			
116	9.05	11.30			
117	8.93	11.07	0	4/13	8:30 AM
		TA2'			
92	9.11	10.91	25	4/13	11:45 AM
93	8.98	10.52			
104	9.23	11.03			
113	9.20	11.01			
116	9.03	10.55			
117	8.90	10.91	25	4/13	11:45 AM
		TA2			
92	9.11	4.63	25	4/13	2:10 PM
93	8.98	4.35			
104	9.23	4.55			
113	9.20	4.64			
116	9.03	4.47			
117	8.90	4.49	25	4/13	2:10 PM
		TA2'			
92	9.15	11.06	70	4/14	8:30 AM
93	9.03	11.33			
104	9.26	11.06			
113	9.21	10.30			
116	9.06	10.19			
117	8.94	*(10.32)	70	4/14	8:30 AM

*Second Time-Sampling rate on counter was not on hold first run

TESTS		SERIAL NO.															
		73	42	63	88	102	110	34	38	35	36	39	44	66	111	115	123
THERMAL SHOCK				X	X												
TRANSPORTATION VIBRATION	86°F							X		X							
	160°F										X		X				
	-65°F								X			X					
WATERPROOFNESS				X	X	X	X	X	X								
AIRCRAFT VIBRATION		X	X											X	X	X	X
MECHANICAL SHOCK						X	X										
FUNCTION-IMPACT	5.5			X		X				X				X			
	12.0	X						X				X				X	
FUNCTION-PROXIMITY	5.5		X						X				X				X
	12.0				X		X				X				X		

Figure 11. FMU-120/B Fuze Environmental Test Schedule

3.4 ENVIRONMENTAL TESTS

Environmental tests were performed to evaluate the capability of the fuze to perform its intended function within operating specifications after experiencing varied adverse environmental conditions. The environmental tests performed are shown in the test schedule and flow chart (Figures 11 and 12), respectively. Table 2 is a tabulation of the results of these tests. Post test analysis was accomplished for each observed abnormality during testing to determine the cause. This failure analysis data is summarized in Table 3.

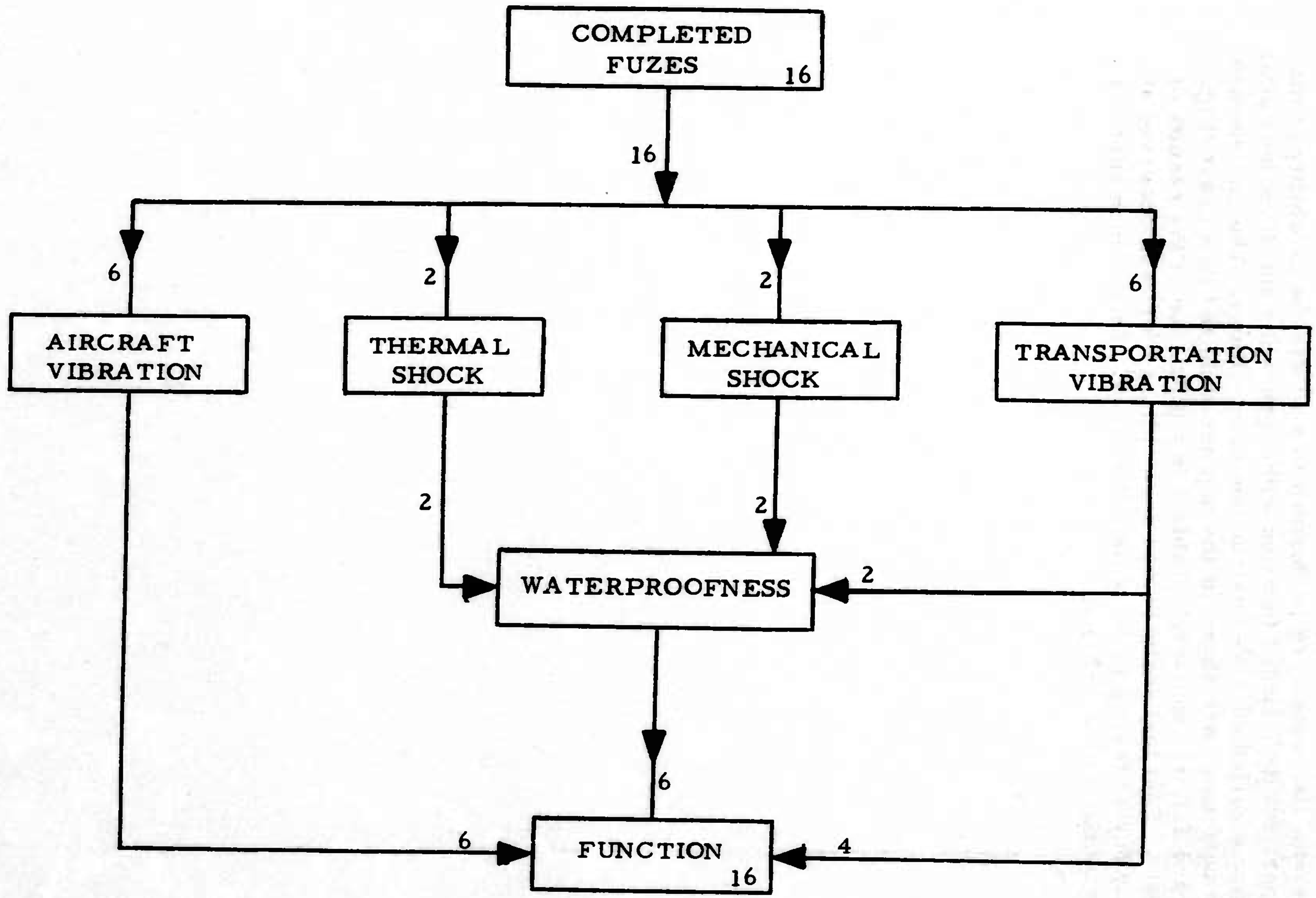

Figure 12. FMU-120/B Fuze Environmental Test Flow Chart

TABLE 2. SUMMARY OF ENVIRONMENTAL TEST RESULTS

S/N	FUNCTION				TIMING RESULTS		
					TIME FROM LANYARD RELEASE TO		
	IMPACT		PROXIMITY		POWER APPLICATION	GAG ROD REMOVAL	ROTOR ARMING
	5.5 Sec	12 Sec	5.5 Sec	12 Sec			
34		+70°F			1.2	5.0	12.4
35	+70°F				1.3	4.5	5.8
36				+160°F	1.2	5.0	11.7
38			-65°F		1.2	4.8	6.2
39		+70°F			1.1	4.2	12.0
42			-65°F		1.5	5.3	6.5
44			+160°F		1.2	4.7	5.6
66	-65°F				1.8	5.2	6.3
73		+75°F			1.1	4.1	12.1
88				-65°F	1.8	5.2	14.6
102	+160°F				1.0	4.2	5.3
110				-65°F	1.4	5.0	14.0
111				+70°F	1.2	4.2	11.9
115		+70°F			1.3	4.3'	13.0
63	+160°F				1.1	DID NOT ARM	
123	-65°F				1.6	DID NOT ARM	

TABLE 3. FAILURE SYNOPSIS

S/N	PRIOR TREATMENTS	FAILURE	NOTES
63	THERMAL SHOCK WATERPROOFNESS	DID NOT ARM DURING FUNCTION TEST. NO ROTOR OPERATION.	NO CAUSE FOUND. SUSPECT POOR CONTACT BETWEEN ROTOR AND ELECTRONICS OR ELECTRONICS AND S & A.
123	AIRCRAFT VIBRATION	DID NOT ARM. ROTOR OPERATION EARLY.	VOLTAGE REGULATOR OPERATION IMPROPER. MOST LIKELY FAILURE OPEN R3, BOARD NO. 2.

SECTION IV

CONCLUSIONS AND RECOMMENDATIONS

4.1 CONCLUSIONS

The following conclusions have been reached as a result of this program.

The effort to configure the FMU-120/B to be compatible with the HOBO EO and the LGB Systems was successful.

The versatility of the basic MK344, FMU-114, and FMU-120 Fuzes is such that they can be modified quickly to meet the requirements of a wide variety of bomb systems.

The only FMU-120/B Fuze failures were attributed to quality control. Enforcement of stricter quality control procedures should make it possible to produce a fuze capable of meeting the desired reliability of 95 percent.

4.2 RECOMMENDATIONS

The FMU-120/B contains selectable arming times, allowing utility with a broader range of bomb systems. As new munitions are developed, the FMU-120/B Fuze should be considered. This fuze can be again further redesigned with minimum technical risk to be compatible with other guided and unguided bomb applications.

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DOCUMENT CONTROL DATA - R & D		
(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)		
1. ORIGINATING ACTIVITY (Corporate author) Fairchild Camera and Instrument Corp. 300 Robbins Lane, Syosset, NY 11791	2a. REPORT SECURITY CLASSIFICATION UNCLASSIFIED	
	2b. GROUP	
3. REPORT TITLE DESIGN AND DEVELOPMENT OF FMU-120/B BOMB FUZE		
4. DESCRIPTIVE NOTES (Type of report and inclusive dates) Final Report (10 November 1972 - February 1974)		
5. AUTHOR(S) (First name, middle initial, last name) David Goldstein		
6. REPORT DATE July 1974	7a. TOTAL NO. OF PAGES 38	7b. NO. OF REFS
8a. CONTRACT OR GRANT NO. F08635-73-C-0049 b. PROJECT NO. 1996 c. Task No. 01 d. Work Unit No. 01	9a. ORIGINATOR'S REPORT NUMBER(S) ORD-AP-33 9b. OTHER REPORT NO(S) (Any other numbers that may be assigned this report) AFATL-TR-74-115	
10. DISTRIBUTION STATEMENT Distribution limited to U.S. Government agencies only; this report documents test and evaluation; distribution limitation applied July 1974. Other requests for this document must be referred to the Air Force Armament Laboratory (DLJF), Eglin Air Force Base, Florida 32542.		
11. SUPPLEMENTARY NOTES Available in DDC	12. SPONSORING MILITARY ACTIVITY Air Force Armament Laboratory Air Force Systems Command Eglin Air Force Base Florida	

13. ABSTRACT

This report relates the results of the applied research, design, development and testing of the FMU-120/B Bomb Fuze. The program was fully successful with regard to meeting the technical goals of (1) functional compatibility with nose well installation, (2) electrically powered from the accessible and visible front face of the fuze, (3) compatibility with the laser guided bomb (LGB) and HOBO EO Weapon Systems, (4) providing operation from a 200-VDC to 300-VDC supply, and (5) including ground selectable 5.5-and 12.0-second arming times. Laboratory and field tests have demonstrated that the developed fuze meets the environmental and functional boundaries as delineated in the subject scope of work. The final fuze design was designated as the FMU-120/B Guided Bomb Proximity Fuze.

DD FORM 1 NOV 65 1473

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14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
FMU-114/B Bomb Fuze						
FMU-120/B Bomb Fuze						
MK344 Bomb Fuze						
MK31 Safety Device						